

# WHAT IS CLAIMED IS:

1. A method of monitoring the abnormality of battery equipment which stores electric power by being charged and discharges the stored power to a load, the method comprising the steps of:

- 5       measuring the voltage and current of the battery equipment at each power discharging to the load;  
       getting the performance recovery characteristics to the discharge current of the battery equipment based on the measured voltage and current;  
       monitoring at least the variation of recovering voltage immediately  
 10   before or after the ceasing of discharge to the load; and  
       diagnosing the abnormality of the battery equipment based on the result of monitoring.

2. A method of monitoring the abnormality of battery equipment according to claim 1 further including the steps of:

- 15       predicting the recovery pattern of discharge voltage from the peak time of the discharge current of the battery equipment; and  
       judging the battery equipment to be abnormal if the discharge voltage which has been measured immediately before or after the ceasing of discharge to the load is lower by a predetermined value than the predicted discharge  
 20   voltage on the recovery pattern at the same time point as of the discharge voltage immediately before or after the ceasing of discharge.

3. A method of monitoring the abnormality of battery equipment according to claim 1 further including the steps of:

- getting an approximate formula of the recovery pattern of discharge  
 25   voltage from the peak time of the discharge current of the battery equipment;

and

judging the battery equipment to be abnormal if the correlation factor between the approximate data used for the calculation of the approximate formula and the approximate formula is equal to or smaller than a threshold value or if the square mean error of the approximate data from the approximate formula is larger than a reference value.

4. A method of monitoring the abnormality of battery equipment according to claim 1 further including the steps of:

getting the locus of the discharge voltage characteristics to the discharge current of the battery equipment; and

judging the battery equipment to be abnormal if the locus deviates from a reference locus, causing the discharge voltage measured immediately before or after the ceasing of discharge to the load to become not higher than a predetermined voltage.

5. Apparatus for monitoring the abnormality of battery equipment, which stores electric power by being charged and discharges the stored power to a load, based on the voltage and current of the battery equipment,

the apparatus monitoring at least the variation of recovering voltage immediately before or after the ceasing of discharge to the load in regard to the discharge voltage recovery characteristics to the discharge current of the battery equipment, and diagnosing the abnormality of the battery equipment.

6. Apparatus for monitoring the abnormality of battery equipment according to claim 5,

wherein the apparatus predicts the recovery pattern of discharge voltage from the peak time of the discharge current of the battery equipment,

and judges the battery equipment to be abnormal if the discharge voltage which has been measured immediately before or after the ceasing of discharge to the load is lower by a predetermined value than the predicted discharge voltage on the recovery pattern at the same time point as of the discharge voltage immediately before or after the ceasing of discharge.

7. Apparatus for monitoring the abnormality of battery equipment according to claim 5, further including a battery replacement judgment section which accumulates the value of current which has been charged since the emergence of battery abnormality until the end of full-charging, and indicates the need of battery replacement if the cumulative current value is smaller than a cumulative current judgment value.

8. A battery system comprising:

battery equipment which stores electric power by being charged and discharges the stored power to a load;

a voltage sensor which measures the charging voltage and discharging voltage of the battery equipment;

a current sensor which measures the charging current and discharging current of the battery equipment; and

a controller which takes in the outputs of the voltage sensor and the current sensor and controls the charging and discharging of the battery equipment, the controller monitoring at least the variation of recovering voltage immediately before or after the ceasing of discharge to the load in regard to the discharge voltage recovery characteristics to the discharge current of the battery equipment, and diagnosing the abnormality of the battery equipment.

9. A battery system according to claim 8,

wherein the battery equipment comprises a secondary battery which is installed on a vehicle such as a motor car and used as energy source for engine starting, and the controller comprises a battery controller which controls the energy flow of the starter motor and generator, and the battery system is applied to the drive system of the car.

10. A battery system according to claim 8 adapted to be applied to a distributed electric power source which includes an AC-to-DC converter which charges the battery equipment up to the state of full-charge based on the commercial power source, and an electric generator which supplies, together with the battery equipment, electric power to the load by way of the AC-to-DC converter when the power supply from the commercial power source is shut off, with momentary load variations being treated by the battery equipment.

11. A battery system according to claim 8 adapted to be applied to a drive system of a fuel-cell car which includes a fuel cell which extracts electric power from fuel, and a motor controller which controls a motor based on power from the fuel cell and the battery equipment by way of an inverter, with momentary load variations being treated by the battery equipment the response of which is faster than that of the fuel cell.